

REMARKS

Claims 1 and 3-11 are pending in the present Application. Claims 1, 3, 5, 7, 9 and 11 have been withdrawn, claims 4, 6, 8 and 10 have been amended, leaving Claims 4, 6, 8 and 10 for consideration upon entry of the present Amendment.

Claims 4, 6, 8 and 10 have been amended to better define the invention. Support for this amendment can be found in claim 1, as originally filed, page 9, line 22 through page 10, line 14, and through out the specification. No new matter has been introduced by these amendments.

Reconsideration and allowance of the claims are respectfully requested in view of the above amendments and the following remarks.

Claim Rejections Under 35 U.S.C. § 112, Second Paragraph

Claims 4 and 6 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. (Office Action dated 12/12/2007, page 3) In particular, the Examiner stated that the recitation of the limitation of “the furnace” in claim 4, line 9, lacks antecedent basis. (Office Action dated 12/12/2007, page 3) Further, the Examiner stated that the recitation of “partial pressure” is traditionally a value with unit of pressure (atm, Pa, etc.). (Office Action dated 12/12/2007, page 3) Appropriate correction is requested.

As noted above, claims 4 and 6 have been amended to better define the invention. Applicants believe these amendment overcome the rejection of claims 4 and 6 under 35 U.S.C. § 112, second paragraph. Applicants respectfully request a withdrawal of the rejection under 35 U.S.C. § 112, second paragraph, and allowance of the claims.

Claim Rejections Under 35 U.S.C. § 103(a)

Claims 4, 6, 8, and 10 stand rejected under 35 U.S.C. § 103(a), as allegedly unpatentable over Smalley et al. (US 2002/0098135 A1)(hereinafter “Smalley”) in view of Iyer et al. (US 7,261,871 B2)(hereinafter “Iyer”). (Office Action dated 12/12/2007, page 4) Applicants respectfully traverse this rejection.

For an obviousness rejection to be proper, the Examiner must meet the burden of establishing a *prima facie* case of obviousness, i.e., that all elements of the invention are disclosed in the prior art; that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention, contain some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combined references; and that the proposed modification of the prior art had a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988); *In Re Wilson*, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970); *Amgen v. Chugai Pharmaceuticals Co.*, 927 U.S.P.Q.2d, 1016, 1023 (Fed. Cir. 1996).

As presently amended, independent claim 4 recites:

A method for producing a fibrous carbon characterized by stacking of carbon hexagonal planes having one or double directional growth axis, wherein

- (1) carbon content is more than 95wt%;
- (2) the diameters range from 3.5 to 79.0 nm;
- (3) the aspect ratio (length per diameter) is more than 20; and
- (4) the carbon hexagonal planes align perpendicular to the fiber axis

with no continuous hollow core therein, the method comprising:

using carbon black-supported metal mixture or alloy catalysts, wherein the metal mixtures or alloys comprise nickel as a major catalyst, and iron or molybdenum as secondary metals; the carbon black is characterized by less than 100m²/g BET-surface area, 20 - 60 nm particle size, and more than 10wt% oxygen content; and the carbon black-supported catalyst contains 0.1 - 60wt% metal mixture or alloy per carbon black; and

reducing the catalyst 1 - 3 times in a furnace in gas containing 5 - 40 v/v% hydrogen in inert gases such as nitrogen, argon or helium at 400 - 500°C for 1 - 48 h; and

introducing a carbon source into the furnace at the flow rate of 0.5 - 40 sccm per 1 mg catalyst, where the carbon source comprises hydrocarbons containing 2 - 6 carbon atoms or mixtures of aforementioned hydrocarbons and hydrogen.

Smalley is generally directed to forming an array of single-wall carbon nanotubes ("SWNT"). (Abstract) In particular, Smalley discloses a method for producing continuous **macroscopic** carbon fibers from SWNTs. ([0007]) Smalley also discloses a method for producing SWNTs in which a laser beam vaporizes material from a target comprising, consisting essentially of or consisting of a mixture of carbon and one or more Group VI or

Group VIII transition metals. ([0064]) The method disclosed by Smalley also produces significant amounts of SWNTs that are arranged as ropes, i.e, the single-wall carbon nanotubes run parallel to each other. ([0064]) Smalley does not disclose method for producing fibrous carbon as presently claimed. In particular, Smalley does not teach or suggest a method for producing fibrous carbon comprising using carbon black-supported metal mixture or alloy catalysts.

As noted above, the claimed invention requires the use of carbon black-supported metal mixture or alloy catalysts. The Examiner points to [0226] as evidence that Smalley discloses the use of carbon black-supported metal mixture or alloy catalysts. Applicants respectfully disagree. Applicants respectfully submit that paragraphs [0221]-[0226] describe research efforts directed to replacing Li metal anodes with Li-carbon intercalation anodes. Paragraphs [0221]-[0226] note that graphite was used in current generation of Li-carbon intercalation anodes. [0221] Graphite was selected primarily because the solid state chemistry of Li-graphite was well understood. ([0221]) However, as noted by Smalley, the use of graphite in Li-carbon intercalation anodes created other problems including:

the best electrolytes (e.g., LiClO_4 dissolved in propylene carbonate) which have good Li conductivity at ambient T also co-intercalate by solvating the Li^{+} , leaving to exfoliation of the graphite, dimensional instabilities and premature failure, and

the diffusivity of Li^{+} in graphite is a low at ambient T, controlled by the large barrier for jump diffusion (commensurate lattice) between adjacent hexagonal interstitial sites in the graphite lattice.

([0222]-[0224]) Paragraph [0226] notes that “research explored the use of other forms of (non-crystalline) carbon: carbon black” was conducted to overcome the problems recited above. Paragraph [0226] further stated “[i]n general the cycling behavior of these materials is much worse than graphite, and the hydrogen-containing materials also exhibit large hysteresis in cell potential vs. Li concentration between charge and discharge half-cycles, a very undesirable property for a battery.” Thus, paragraph [0226] does not teach or suggest carbon black-supported metal mixture or alloy catalysts; or a method of producing fibrous carbon as claimed using carbon black-supported metal mixture or alloy catalysts.

Further, Applicants respectfully assert that Smalley does not teach or suggest the limitation “reducing the catalyst 1 –3 times in a furnace in gas containing 5 – 40 v/v%

hydrogen in inert gases such as nitrogen, argon or helium at 400 - 500°C for 1 - 48 h”, required by claim 4, as currently amended.

The Examiner also stated that it would have been obvious to one of ordinary skill in the art to modify the teaching of Smalley “because the choice of carbon source is a design parameter and that one have been motivated to make such a modification because Smalley teaches that research of other forms of carbon such as carbon black have been shown to exhibit much large Li capacities than graphite, an important quality for battery technology”. (Office Action dated 12/12/2007, page 6) Applicants respectfully disagree. The present invention is directed to a method for producing metal fibrous carbon, the method comprises using carbon black-supported metal mixture or alloy catalysts. Smalley does not teach or suggest carbon black-supported metal mixture or alloy catalysts. Therefore, Applicants respectfully submit that Smalley cannot teach or suggest a method for preparing fibrous carbon, using carbon black-supported metal mixture or alloy catalysts. Further, Applicants note that Smalley teaches the use of carbon black as an alternative to graphite in making Li-carbon intercalation anodes. Smalley does not indicate that carbon black was used, or researched for use as anything other than making Li-carbon intercalation anodes. Since, Smalley does not discuss using carbon black-supported metal mixture or alloy catalysts, Applicants submit that one of skill in the art would not have been motivated to modify Smalley’s method for producing SWNTs in which a laser beam vaporizes material from a target comprising, consisting essentially of or consisting of a mixture of carbon and one or more Group VI or Group VIII transition metals to include to use of carbon black-supported metal mixture or alloy catalysts.

Iyer does not make up for the deficiencies of Smalley. Iyer is directed to method for the production or synthesis of carbon nanotubes as free-standing films or nanotube mats by the thermal decomposition of transition metal complexed alkynes with aryl, alkyl, alkenyl, or alkynyl substituents. (Abstract) In particular, transition metal (e.g. Co, Ni, Fe, Mo) complexes of diarylacetylenes, e.g. diphenylacetylene, and solid mixtures of these complexes with suitable, additional carbon sources are heated in a vessel. (Abstract). Iyer does not teach or suggest a method for producing fibrous carbon comprising using carbon black-supported

metal mixture or alloy catalysts.

In summary, the combination of Smalley and Iyer does not teach or suggest all elements of independent claim 4. In particular, the combination of Smalley and Iyer does not teach or suggest a method for producing fibrous carbon comprising using carbon black-supported metal mixture or alloy catalysts. Further, Applicants believe that one of skill in the art would not have been motivated to modify Smalley's method, or Iyer's method to include to use of carbon black-supported metal mixture or alloy catalysts. Thus, since the combination of Smalley and Iyer does not teach or suggest all elements of independent claim 4 and further since there is no motivation to modify the references as suggested by the Examiner, Applicants believe that the Examiner has not made a *prima facie* case of obviousness. Claims 6, 8 and 10 depend from independent claim 4 and include all limitation thereof. Applicants respectfully request a withdrawal of the § 103 rejection over Smalley in view of Iyer and an allowance of the claims.

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance are requested.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,

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